

Amended
A3

39. (Amended) A semiconductor assembly having [an] a void-free, aluminum-containing material within contact holes in an insulating layer overlying a substrate, the semiconductor assembly formed by the method comprising:

providing a semiconductor substrate having a dielectric layer overlying a semiconductor substrate, the insulating layer having contact holes extending therethrough;

filling the contact hole with a metal material including aluminum as a major constituent;

and

modifying the characteristics of the metal material by diffusing at least a second metal material thereinto to form a void-free, homogeneous alloy fill material in the contact holes.

REMARKS

The Office Action mailed November 9, 2000, has been received and reviewed. Claims 1 through 44 are currently pending in the application. Claims 1 through 44 stand rejected. The application is to be amended as previously set forth. All amendments are made without prejudice or disclaimer. Reconsideration is respectfully requested.

35 U.S.C. § 103(a) Obviousness Rejections

Obviousness Rejection Based on Dixit et al. or U.S. Patent No. 5,998,296 to Saran et al. Taken with U.S. Patent No. 4,941,032 to Kobayashi et al.

Claims 1 through 44 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Dixit et al. (IDEM 94) (hereinafter “the Dixit reference”) or U.S. Patent No. 5,998,296, issued to Saran et al., (hereinafter “the Saran patent”) taken with U.S. Patent No. 4,941,032, issued to Kobayashi et al., (hereinafter “the Kobayashi patent”). Applicant submits that the combination of these references does not teach or suggest the presently claimed invention.

The Office Action states that the Dixit reference and the Saran patent individually teach all of the elements of the present inventions except for the recitation of the advantages of

inclusion of alloy, the recitation of homogeneous alloy and the various alloying elements. The Office Action further states that it would have been obvious to combine the aforementioned references with the Kobayashi patent wherein the homogeneous aluminum alloy can be obtained and wherein an aluminum alloy having improved heat resistance can be obtained. It was further noted that any alternative alloy material not recited otherwise would have been obvious.

The Applicant submits that the instant invention is not taught or suggested in the prior art. The Federal Circuit has stated that a reference should be considered as a whole, and portions arguing against or teaching away from the claimed invention must be considered. Bausch & Lomb, Inc. v. BarnesHind/Hydrocurve, Inc., 230 USPQ 416 (Fed. Cir. 1986). The prior art references cited by the Examiner "would likely *discourage* the art worker from attempting the substitution suggested by [the applicant]." Gillette Co. v. S.C. Johnson & Son, Inc., 16 USPQ2d 1923 (Fed. Cir. 1990). The fact that the applicant achieved the claimed invention by doing what those skilled in the art had suggested should not be done is a fact strongly probative of nonobviousness. Kloster Speedsteel AB v. Crucible Inc., 230 USPQ 81 (Fed. Cir. 1986), on rehearing, 231 USPQ 160 (Fed. Cir. 1986). Additionally, "it is impermissible to use the claimed invention as an instruction manual or 'template' to piece together the teaching of the prior art so that the claimed invention is rendered obvious One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention." In re Fritch, 23 U.S.P.Q.2d 1780 (Fed. Cir. 1992).

Furthermore, the Office Action has not established a *prima facie* case of obviousness. The case of Ex parte Obukowicz, 27 U.S.P.Q.2d 1063 (B.O.P.A.I. 1993) sets forth the current case law regarding Section 103 rejections:

In proceedings before the Patent and Trademark Office, the examiner bears the burden of establishing a *prima facie* case of obviousness based upon the prior art. In re Piasecki, 745 F.2d 1468, 1471-72, 223 U.S.P.Q. 785, 787-88 (Fed. Cir. 1984). The examiner can satisfy this burden only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art *would lead* that individual to combine the relevant teachings of the references. In re Fine, 837 F.2d 1071, 1074, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir.

1988). Indeed, the teachings of references can be combined only if there is some suggestion or incentive to do so. ACS Hospital Systems, Inc. v. Montefiore Hospital, 723 F.2d 1572, 1577, 221 U.S.P.Q. 929, 933 (Fed. Cir. 1984).

The Applicant respectfully disagrees with the Office Action's assessment of the Dixit reference and the Saran patent. The Dixit reference teaches aluminum hole filling being achieved by conventional sputter deposition of an Al-Cu alloy to bridge the top of each hole metal, leaving a void inside the hole. The wafer is then transferred under vacuum in a high pressure chamber with radiant heaters and the bridged Al-Cu is forced into the holes by pressuring the chamber with argon. Additionally, the Dixit reference teaches that a Ti/TiN barrier is sputter deposited at the bottom of the semiconductor and on top of the aluminum layer.

Independent claims 1, 23 and 39 recite a semiconductor with an aluminum alloy material in the contact holes having an insulating layer overlying a substrate. This product was created by depositing an aluminum material on an exposed surface of the insulating, heating the aluminum material to partially fill the holes, applying pressure to the aluminum material to fill the holes, depositing a different metal material over the contact holes and forming a homogeneous metal fill material in the contact holes. This process creates a different product than that contained in the Dixit reference. The present invention corrects for the deformations contained as a result of the Dixit reference product. As stated in the specification of the present invention on pages 4 and 5, this application alleviates the problems of void being formed inside each hole below the filled or bridged mouth. The present invention also eliminates the need for deposition of TiN, as taught in the Dixit reference, which helps conserve the target material composition. (*See*, page 9, lines 14 to 20 of the present specification). Additionally, as stated above, the present invention corrects the aluminum bridge over the hole or via that is deformed or extruded inwardly. Thus, the present invention results in complete filling of the hole or via and is, thus, designed to overcome the limitations of the Dixit reference. Accordingly, the Dixit reference merely recites the shortcomings of prior art structures and, thus, teaches away from the present invention.

Similarly, the present invention overcomes the limitations contained in the Saran patent. The Saran patent teaches first forming a fill metal layer over the semiconductor, forming a surface coating over the metal fill layer and then applying high pressure on the surface coating to force the fill metal into the opening. (*See* Saran, column 1, lines 55 to 61 and column 2, line 50 to column 5, line 5). As a result, the Saran patent contains contacts that are deformed or extrude inwardly. The forced fill process of the present invention completely and evenly fills all of the contact holes unlike the Saran patent, thus creating a different and more advantageous product. Thus, the Saran patent teaches away from the present invention.

Applicant also disagrees with the Office Action's assessment of the Kobayashi patent. The Kobayashi patent teaches using an aluminum alloy as material for a metal electrode. It fails to teach using the aluminum alloy within contact holes in an insulating layer, as claimed in the present invention. The aluminum alloy of the Kobayashi patent is used only as a metal electrode which can be electrically connected to a semiconductor. In contrast, the formation of the homogeneous aluminum alloy of the present invention is formed within the contact holes or via of the wafer thus improving strength, stress migration and electromagnetic properties of the contact or vias. Because there are no contact holes in the structure of the Kobayashi patent, the Kobayashi patent actually teaches away from a semiconductor structure having a homogeneous aluminum alloy with an insulating layer. Therefore, there is no motivation in Kobayashi to combine any of its elements with the elements of the Dixit reference or the Saran patent particularly when a number of elements are non-existent therein. To combine the references as the Office Action exhibits, is impermissibly relying on hindsight reconstruction. In view of the foregoing, applicants respectfully contend that the Dixit reference and Saran and Kobayashi patents fail to teach the elements contained in the claims of the present invention and thus do not qualify as 103(a) prior art.

Neither the Dixit reference, the Saran patent or the Kobayashi patent, either alone or in combination, teach or suggest all the claim limitations of independent claims 1, 23 and 39 of

which claims 2-22, 24-28 and 40-44 subsequently depend upon. Therefore, reconsideration and withdrawal of the rejection of claims 1-44 under Section 103(a) are respectfully requested.

ENTRY OF AMENDMENTS

The amendments to the claims above should be entered by the Examiner because the amendments are supported by the as-filed specification and drawings and do not add any new matter to the application. Further, the amendments do not raise new issues or require a further search.

CONCLUSION

In view of the amendments and remarks presented herein, applicants respectfully submit that the amended claims define patentable subject matter. If questions should remain after consideration of the foregoing, the Examiner is kindly requested to contact applicants' attorney at the address or telephone number given herein.

Respectfully Submitted,



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